

What is claimed is:

1. An endoscope comprising:
an elongate inserted section;
an illuminating light projecting means projecting an illuminating light from the distal end side of said inserted section;
an objective optical system arranged on the distal end side of said inserted section, having at least two optical systems receiving the light from an object illuminated by said illuminating light and forming at least two images not equal to each other; and
one image transmitting optical system arranged within said inserted section and transmitting said two images in common.
2. An endoscope according to claim 1 wherein said two optical systems have two optical axes eccentric from said optical axis on both sides of the optical axis of said image transmitting optical system and said two optical systems form images having a parallax between each other.
3. An endoscope according to claim 1 wherein said two optical systems have two optical axes not parallel with each other and form images different in the visual field direction from each other.
4. An endoscope according to claim 1 wherein said objective optical system has said two optical systems arranged in parallel on said object side and one optical

system arranged in common on the image side of said two optical systems and said two optical systems are formed of negative lenses.

5. A stereoendoscope comprising:

an elongate inserted section;

an illuminating light projecting means projecting an illuminating light from the distal end side of said inserted section;

an objective optical system arranged on the distal end side of said inserted section and forming the light from the object illuminated by said illuminating light as plural images having a parallax between each other through plural incident pupils; and

one image transmitting optical system contained at least partly within said inserted section and transmitting said plural images having a parallax between each other by said objective optical system.

6. A stereoendoscope according to claim 5 wherein the diameter of the incident pupil of said objective optical system is substantially the same as the radius of said relay optical system or is smaller than it.

7. A stereoendoscope according to claim 5 wherein an image taking means taking the plural images having a parallax between each other and transmitted by said image transmitting optical system is arranged at the rear end of said inserted section within which said objective optical system and said image transmitting optical system are contained.

8. A stereoendoscope according to claim 5 wherein said objective optical system is formed of two negative

lenses arranged in parallel with each other and one positive lens group arranged on the optical axis coinciding with the optical axis of said two negative lenses and said image transmitting optical system in the order mentioned from the object side.

9. A stereoendoscope comprising:

an elongate inserted section;

an illuminating light projecting means projecting an illuminating light from the distal end side of the inserted section;

an objective optical system arranged on the distal end side of said inserted section and forming plural images having a parallax between each other respectively in spatially separated positions for the object illuminated by said illuminating light; and

one image transmitting optical system transmitting said plural images.

10. A stereoendoscope according to claim 9 having at least one image taking means taking the plural images having a parallax and made on the final image surface of said image transmitting optical system.

11. A stereoendoscope according to claim 9 wherein the petzval sum of said objective optical system is a negative value.

12. A stereoendoscope according to claim 9 wherein the optical axis of said image taking means is inclined to the optical axis of said image transmitting optical system.

13. A stereoendoscope according to claim 9 having an adapter optical system for re-forming the plural images

having a parallax and made on the final image surface of said image transmitting optical system and varying the relative distance between the plural images within said final image surface.

14. A stereoendoscope comprising:

an elongate inserted section;

an illuminating light projecting means projecting an illuminating light from the distal end side of said inserted section;

an objective optical system arranged on the distal end side of said inserted section and forming plural images having a parallax between each other respectively in spatially substantially coinciding positions for the object illuminated by said illuminating light; and

one image transmitting optical system transmitting said plural images.

15. A stereoendoscope according to claim 14 having a pupil dividing and image forming means for spatially separating the plural images having a parallax and made in the substantially coinciding positions on the final image surface by said image transmitting optical system and forming images and at least one image taking means taking the images formed by said pupil dividing and image forming means.

16. A stereoendoscope according to claim 14 wherein said objective optical system comprises plural front groups and one rear group placed in parallel on the object side and the space between said front groups and said rear group is afocal.

17. A stereoendoscope according to claim 15 wherein said objective optical system comprises plural front groups and one rear group placed in parallel on the object side and said front group is formed of a negative power element and positive power element in the order mentioned from the object side.

18. A stereoendoscope according to claim 15 having an adapter optical system for spatially or timely separating and re-forming the plural images having a parallax and made in the spatially substantially coinciding positions on the final image surface of said image transmitting optical system.

19. A stereoendoscope comprising:

an elongate inserted section;

an illuminating light projecting means projecting an illuminating light from the distal end side of said inserted section;

an objective optical system arranged on the distal end side of said inserted section and forming n images (wherein n is an integer equal to or above 3) having a parallax between each other for the object illuminated by said illuminating light;

less than $n-1$ image transmitting optical systems transmitting the n images;

at least one image taking means taking the respective images; and

a displaying means selectively displaying any two images of the taken plural images in at least one displaying means.

20. A stereoendoscope comprising:

an elongate inserted section;

an illuminating light projecting means projecting an illuminating light from the distal end side of said inserted section;

an objective optical system wherein plural optical systems are arranged in parallel on the distal end side of said inserted section and plural images having a parallax between each other are formed for the object illuminated by said illuminating light;

an image transmitting optical system comprising one optical system transmitting the plural images formed by the objective optical system; and

an image taking means taking at least two images of the plural images transmitted by said image transmitting optical system.

21. A stereoendoscope according to claim 20 wherein said objective optical system is formed of plural optical systems whose petzval sum is negative.

22. A stereoendoscope according to claim 20 wherein said image taking means comprises two image taking devices whose optical axes are inclined respectively to the optical axis of said image transmitting optical system.

23. A stereoendoscope according to claim 20 wherein said image taking means comprises plural image taking devices and the central parts on the image taking surfaces of said plural image taking devices are arranged as inclined to contact the curved surfaces of the images.

24. A stereoendoscope according to claim 20 wherein

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said objective optical system comprises plural front group optical systems in which optical systems are arranged in parallel and a rear group optical system arranged coincidentally with the optical axis of said image transmitting optical system and forming images of the beams from said plural front group optical systems in substantially superimposed positions and said image transmitting optical system transmits substantially superimposed plural images having a parallax between each other and formed by said objective optical system.

25. A stereoendoscope according to claim 24 wherein the positions of the pupils transmitted by said image transmitting optical system are separated from each other.

26. A stereoendoscope according to claim 24 wherein the projected beam from said front group optical system is a substantially afocal beam.

27. A stereoendoscope according to claim 24 wherein the border position of said front group optical system and said rear group optical system is more on the image side than the front side focus position of said rear group optical system.

28. A stereoendoscope comprising:

an elongate inserted section;

an illuminating light projecting means projecting an illuminating light from the distal end side of said inserted section;

an objective optical system arranged within the distal end side of said inserted section; and

an image taking means arranged within said inserted section and taking the object image formed by

said objective optical system,

said objective optical system having two negative lenses arranged in parallel with each other and one positive lens group opposed to said two negative lenses and arranged along the central axis between the optical axes of said two negative lenses in the order mentioned from the object side.

29. An endoscope provided with:

an objective optical system having plural visual field directions and plural pupils corresponding to these visual field directions and arranged so as not to be superimposed and forming at least one object image; and

a transmitting optical system formed to be of a size equal to or larger than the size of the plural pupils from the objective optical system and transmitting rearward the object image and said plural pupils from said objective optical system.

30. An endoscope according to claim 29 having a pupil separating means separating plural pupils corresponding respectively to the beams in said plural different directions and formed by said transmitting optical system and an image forming optical system forming object images formed by the beams included in the range of the pupils corresponding to the separated respective visual field directions.

31. An endoscope according to claim 30 wherein said image separating means is arranged near the plural pupils transmitted by said transmitting optical system on the side on which the rays are projected by said transmitting

optical system.

32. A stereoendoscope according to claim 30 halving plural image taking means receiving respectively plural object images formed by said image forming optical system and forming images.

33. An stereoendoscope according to claim 32 wherein said pupil separating means has an optical member separating into respectively different directions the beams included in the plural pupils formed by said transmitting optical system and a reflecting means directing the plural beams separated by said optical member in a direction substantially parallel with the optical axis of said transmitting optical system and said plural image taking means receive the beams reflected by said reflecting means and take respectively the object images formed by said image forming optical system.

34. An endoscope wherein an objective optical system having plural visual field directions and plural pupils corresponding to these visual field directions and formed so as not to be superimposed on each other and forming object images and a transmitting optical system having a single optical axis and transmitting the object images and plural pupils from said objective optical system are provided,

said objective optical system comprises a front side optical system which receives beams in directions different from each other and projects said beams as plural substantially afocal beams arranged substantially in parallel along the optical axis of said transmitting optical system and a rear side optical system which has a

single optical axis common with said transmitting optical system, converges the plural beams from said front side optical system and forms object images rearward and

said image transmitting optical system transmits rearward the object images and plural pupils formed to be of a size equal to or larger than the size of the plural pupils corresponding to the plural beams from said rear side optical system and from said rear side optical system.

35. An endoscope according to claim 34 wherein an optical system converting said plural beams to plural beams arranged to be substantially parallel with the optical axis of said transmitting optical system is arranged on the projecting side of the beam forming the object image transmitted from said transmitting optical system, an image forming lens receiving only one of said plural beams and an image taking means receiving the object image formed by said image forming lens and taking the image are provided, said image forming lens and image taking means are integrally moved in the direction intersecting with the optical axis of said optical system and only one of said plural beams is selectively incident into said image forming lens.

36. An endoscope according to claim 34 wherein on the projecting side of the beam forming the object image transmitted by said transmitting optical system are arranged an optical system converting said plural beams to plural beams arranged to be substantially parallel with the optical axis of said transmitting optical system, a light path switching means movably arranged in the

direction intersecting with the optical axis of said optical system to selectively rearward transmit only one of said plural beams, an image forming optical system receiving one beam selected by said light path switching means and forming an object image and an image taking means receiving the object image formed by said image forming optical system and taking the image.

37. An endoscope according to claim 34 wherein on the projecting side of the beam forming the object image transmitted by said transmitting optical system are provided a first optical system converting said plural beams to plural beams arranged to be substantially parallel with the optical axis of said transmitting optical system, a second optical system receiving said plural beams and forming an image, a beam switching means provided between said first optical system and second optical system and selectively passing only one of said plural beams and an image taking means receiving the object image formed by said second optical system and taking the image.

38. An endoscope according to claim 35 wherein a means setting plural pupils corresponding respectively to the beams in said plural different directions is provided in either of said objective optical system and transmitting optical system.

39. An endoscope according to claim 34 having an image forming optical system having an optical axis common with said transmitting optical system and forming an object image formed of the beam included in the range of plural pupils corresponding to the respective visual

field directions from said transmitting optical system.

40. An endoscope according to claim 34 having one image taking means receiving plural object images formed by said image forming optical system and taking the images.

41. An endoscope according to claim 39 wherein said image forming optical system is an ocular optical system forming plural object images corresponding to different visual field directions so as to be observable with the naked eyes.

42. An endoscope according to claim 39 wherein a means setting plural pupils corresponding to the respective beams in said plural different directions is provided in either of said objective optical system and said transmitting optical system.

43. An endoscope according to claim 41 wherein a means setting plural pupils corresponding to the respective beams in said plural different directions is provided in either of said objective optical system and said transmitting optical system.

44. An endoscope wherein an objective optical system having plural visual field directions and plural pupils corresponding to these visual field directions and formed so as not to be superimposed on each other and forming plural object images and a transmitting optical system having a single optical axis are provided,

said objective optical system comprises a front side optical system which receives beams in directions different from each other and projects said beams as plural substantially afocal beams arranged substantially

in parallel along the optical axis of said transmitting optical system and plural rear side optical systems arranged in parallel to receive plural projected beams from said front side optical system, converge plural object images and form plural object images respectively in the rear,

said image transmitting optical system is formed to be of a size equal to or larger than the size of the plural pupils corresponding to the plural beams from said rear side optical systems and transmits rearward the plural object image and plural pupils from said plural rear side optical systems.

45. An endoscope wherein an objective optical system having plural visual field directions and plural pupils corresponding to said plural visual field directions and a transmitting optical system having a single optical axis are provided,

said objective optical system comprises a front side optical system including plural pupils receiving respectively plural beams in directions different from each other and a prism optical system varying at least one of said beams and converting the respective beams to beams directed in substantially the same direction and a rear side optical system forming object images made of plural beams from said front side optical system in substantially the same positions and

said transmitting optical system transmits rearward the object images and plural pupils from said rear side optical system.

46. An endoscope wherein an objective optical

system having plural visual field directions and plural pupils corresponding to said plural visual field directions and a transmitting optical system having a single optical axis are provided,

said objective optical system has a front side optical system including plural lenses having optical axes in directions different from each other and a prism optical system receiving the respective beams having passed through said plural lenses and converting said beams to plural beams arranged substantially in parallel along the optical axis of said transmitting optical system and a rear side optical system having a size including the beams projected out of said front side optical system and having a single axis and a convergence for projected rays to simultaneously form images of the plural beams and

said transmitting optical system transmits rearward the object images and plural pupils from said rear side optical system.

47. An endoscope according to claim 46 wherein an ocular optical system having an optical axis common with said transmitting optical system is arranged on the projecting side of the beams forming the object images

48. An endoscope according to claim 46 wherein an optical system converting said plural beams to plural beams arranged substantially in parallel with the optical axis of the transmitting optical system, a reflecting means directing the plural beams projected out of said optical system in respectively different directions, plural image forming optical systems provided in the

respective light paths of the respective beams to form object images of the respective beams reflected by said reflecting means and plural image taking means taking images by receiving the respective object images formed by said image forming optical system are provided on the projecting side of the beams forming the object images transmitted by said transmitting optical system.

49. An endoscope according to claim 46 wherein an optical system converting said plural beams to plural beams arranged substantially in parallel with the optical axis of the transmitting system is arranged on the projecting side of the image position formed by said transmitting optical system, an image forming lens receiving only one of the plural beams from said optical system and an image taking means taking images by receiving the object images formed by this image forming lens are provided, said image forming lens and image taking means are formed to be integrally moved in the direction intersecting with the optical axis of said optical system and only one of said plural beams is selectively incident upon said image forming lens.

50. An endoscope according to claim 46 wherein an optical system converting said plural images to plural images arranged substantially in parallel with the optical axis of the transmitting optical system, a light path switching means arranged movably in the direction intersecting with the optical axis of said optical system to deliver rearward only one of the plural beams from said optical system and an image forming optical system receiving the beams selected by said light path switching

means and forming object images in the rear are provided on the projecting side of the image position formed by said transmitting optical system.

51. An endoscope wherein an objective optical system having plural visual field directions and plural pupils corresponding to said plural visual field directions and a transmitting optical system having a single optical axis are provided,

said objective optical system has a front side optical system including a pupil dividing means dividing pupils into said plural pupils, a prism member making the directions in which the beams corresponding to the divided respective pupils are incident different from each other and plural lenses having optical axes in directions different from each other and

a rear side optical system forming images of plural beams simultaneously on the image surface and having a single optical axis and a convergence for the projected beams and

said transmitting optical system transmits rearward the object images and plural pupils from said rear side optical system.

52. An endoscope having an objective optical system comprising plural visual field directions, plural pupils corresponding to said visual field directions and an optical system forming images in the same positions of the beams from the respective pupils.

53. An endoscope according to claim 52 having a passage interception switching means selectively passing one of the plural pupils from said objective optical

system.

54. An endoscope wherein the objective optical system comprises a front side optical system including a lens having a negative refractive force and a rear side optical system which includes a lens having a positive refractive force and has a convergence,

said front side optical system includes plural lenses having optical axes in directions different from each other and prism receiving beams in directions different from each other and converting said beams to plural beams arranged substantially in parallel with the optical axis of a transmitting optical system delivering said beams and

said rear side optical system has a size including the beams projected out of said front side optical system and a single optical axis and forms images of objects of said plural beams simultaneously on the image surface.

55. An endoscope wherein an objective optical system having plural visual field directions and an image taking means receiving object images formed by said objective optical system and taking images are provided,

said objective optical system comprises a front side optical system including a prism optical system receiving beams in plural directions different from each other and converting said beams to plural beams arranged substantially parallel, a means setting plural pupils corresponding to the respective beams and a passage interception switching means selectively passing one of said plural pupils and a rear side optical system having

a single optical axis and a convergence and

said image taking means takes the object images corresponding to the pupils selected by said passage interception switching means and formed by said rear side optical system.

56. An endoscope according to claim 55 wherein said image taking means is a solid state image taking device.

57. An endoscope provided with:

an objective optical system having plural pupils arranged so as not to be superimposed on each other and forming plural object images having passed through said plural pupils; and

an image transmitting optical system transmitting rearward said plural object images and pupils from said objective optical system.